

Design Criteria for Sewerage Rehabilitation

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The Severn-Trent Water Authority has adopted a two stage approach for the hydraulic design of sewerage rehabilitation schemes. The procedure is based on a levels of service approach and utilises WASSP-SIM throughout. The procedure was presented to the WaPUG Autumn meeting in Glasgow in 1986.

Stage I of the procedure determines the extent of the proposals (eg length of replacement sewer) which should be just sufficient to elevate performance to a 'reasonable' level. This will produce the least cost solution. Flooding frequencies defining the lower limit of a reasonable level of service are specified and these are used in conjunction with WASSP-SIM to complete Stage I by assuming that flooding frequency is the same as the return frequency of built-in design storms.

Stage II determines the size of the components which make up the proposals generated from Stage I (eg diameter of proposed replacement sewers). The standards are higher than Stage I in order to protect the investment from future uncertainties in hydraulic demand. Elemental increases in pipe size are relatively cheap compared with construction costs and this Stage should aim at a higher level of flooding protection in the vicinity of the proposed works. This will be equivalent to a 'desirable' level of service where flooding should be expected only from very rare events, if ever. No equivalent flooding criteria are available however but the familiar methods and criteria for greenfield design as published in WAA Sewers for Adoption 2, are deemed to provide a desirable level of service and, in conjunction with WASSP-SIM, these criteria are currently recommended for Stage II.

The Stage II criteria from Sewers for Adoption are not very suitable for schemes involving sewer renovation and for tank sewers and they are not directly applicable to the design of detention storage tanks. There is therefore a requirement for a flooding (overtopping) criterion. It is also desirable to fully utilise the capabilities of WASSP-SIM to model storage in manholes and to develop criteria which are compatible with Stage I design. For the time being therefore the following criterion is used for Stage II design for detention structures:-

No simulated flooding will occur in the immediate vicinity of the proposed new works from a suitable design storm of 20 year return frequency. This recommendation is based purely on judgement.

It is recognised that the relationship between simulated flooding (SIMFLOOD) where flooding frequency is equated to the return period of the design storm, and actual flooding frequency has not yet been established. There is considerable difficulty in simulating the likely effect of high intensity storms without making special provisions in WASSP-SIM for gully efficiency and variations in

catchment wetness during such extreme events. However, it is considered that a way forward is to determine the range of values of SIMFLOOD for a sewer system which has been designed entirely in accordance with Sewers for Adoption 2.

Consequently an exercise was carried out where two sewer systems were redesigned and the values of SIMFLOOD determined. The two systems chosen were of different size and characteristics such that the full range of criteria was used. The usual principles of good design practice were also observed. The results and conclusions of the exercise are as set out below.

Results

- (i) A broad similarity existed between the simulated flooding performance of both of the redesigned sewer systems despite their different size and characteristics.
- (ii) For the nodes of pipes designed to each of the traditional design categories the return period of the storm required to cause the onset of simulated flooding exceeded the storm return period used to design the pipe by the margins shown below:

Design Return Period	Storm Return period Causing Onset of SIMFLOOD
1 in 1 year	2 - 5 years
1 in 2 years	3 - 6 years
1 in 5 years	30 years

- (iii) The derived SIMFLOOD values are banded into the three categories given in the table below:

Traditional no-surge design criteria	SIMFLOOD results		
	Onset of flooding (R.P.min)	10% of Nodes flooding (R.P min)	30% of Nodes flooding (R.P.min)
1 in 1 yr design pipes	1 in 2 yrs	1 in 6 yrs	1 in 32 yrs
1 " 2 " " "	1 in 3 yrs	1 in 11 yrs	1 in 76 yrs
1 " 5 " " "	1 in 31 yrs	1 in 625 yrs	
150 mm pipes	1 in 3 yrs	1 in 11 yrs	1 in 32 yrs

(R.P min) = Minimum flood return period recorded by the node at: the onset of flooding; where 10% of nodes have flooded; where 30% of nodes have flooded.

Conclusions and Recommendations

- (i) The investigation indicated that the production of hydraulic design criteria based on SIMFLOOD is feasible.
- (ii) The project indicated a broad similarity between the SIMFLOOD results of the two sewerage systems but further systems should be examined to fully develop this approach.

- (iii) A desirable level of service appears to be represented by a very wide range of SIMFLOOD values and it is notable that the onset of SIMFLOOD is as low as 1 in 2 years.
- (iv) From the results it may be concluded that a SIMFLOOD criterion of 1 in 20 years for Stage II design will elevate the performance of about 20% of the system above that which is already deemed to be desirable. This criterion may therefore be over-generous.

Discussion on Messrs Eadon & Gardiners' presentation

J. Packman, Institute of Hydrology.

The results cannot be applied to all catchments as they must be dependant on the slope of the catchment and the freeboard in the system.

A. Gardiner,

Agreed, but this initial study does show some broad similarity between differing types of catchment.

B. Jackson, N.W.W.

Surely there must be a high sensitivity to slope as steep catchments are not generally as prone to surcharge.

A. Gardiner,

The procedure could still be used but some checks should be carried out to ascertain the sensitivity to slope variation.

GENERAL DISCUSSION

G. Roberts, Travers Morgan & Ptnrs.

What are the launch dates and approximate costs of the new software?

Dr. R. Price, H.R.Ltd.

WALLRUS (first release) - Spring '88 - £6500 for new package if no trade in.

WALLRUS (second release)- Spring '89 - no additional cost.

D. Walters, Bolton M.B.C.

Will WALLRUS run in a multi-tasking environment?

Dr. R. Price,

Not at present, but it should do so by Autumn '88 when it will run on both UNIX and OS2. There will however be some time penalty if multi-tasking.

Dr. D Wright, Applied Research & Project Management.

Why is it necessary to have two releases of WALLRUS especially so close together? Would it not be better to wait until all the work on the program is complete and have just one release? When are WIFE and SPIDA due for release?

Dr R. Price,

Two releases due to "User demand". Many users do not want to wait until all the new facilities have been incorporated in WALLRUS.

WIFE is due out in Spring '88 but the release date for SPIDA has not yet been determined.

D. Dring, S.T.W.A.

When will WALLRUS be made available on mainframe?

Dr. R.Price,

The WALLRUS source code for mainframe is scheduled for release in Spring '89.

G. Tindale, Roughton & Ptnrs.

Will WALLRUS run on machines having 80386 chips installed?

Dr R. Price,

There should be no problem providing the screen handling is compatible.
